Conjunctive hypothesis sampling: A reconsideration

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Ss were presented with conjunctive concept learning problems in which blank-trial stimuli were used to assess hypothesis sampling patterns. Data were analyzed to show that Ss did not sample single values randomly and independently and respond on the basis of these single values. Evidence was also presented to show that Ss do not sample hypotheses with replacement after an error.

Nahinsky & Slaymaker (1969) have presented evidence that Ss sample two-value combinations rather than single cues independently from an initial positive instance in a two-dimensional conjunctive concept-learning task. They also argued that Ss narrow down the pool of sampled hypotheses to the correct one by eliminating hypotheses incompatible with information on subsequent trials. This paper presents a reanalysis of some of the findings in order to strengthen the findings.

METHOD

Ninety Ss were each presented with two conjunctive concept-identification tasks in succession in which two of three dimensions varied were relevant. The dimensions and values were (1) shape of figures—crosses, circles, or squares; (2) shading of figures—black, striped, or white; and (3) number of figures—one, two, or three. S was asked to classify each stimulus as a positive or as a negative instance when presented. He was first presented with a positive instance and was so informed. He was next presented with a series of three blank-trial (BT) stimuli in random order, with each stimulus overlapping the initial positive instance by exactly two values such that each pair of values on the positive instance appeared on one BT stimulus. After these BT stimuli, S was presented with a sequence of feedback positive and negative instances in random order and with each positive instance followed by a three-stimulus BT series bearing the same relationship to it as described above. Presentations of feedback stimuli were always followed by information about response correctness with no such feedback following BT stimuli. After two random presentation cycles of feedback stimuli with positive instances always followed by a corresponding BT series, S was asked to guess the correct hypothesis.

In one condition, 30 Ss were given a task with four feedback stimuli, two positive and two negative, with no value overlap between positive and negative instances. In two other conditions involving 30 Ss each,

there were six feedback stimuli, two positive and four negative, with varying degrees of value overlap between positive and negative instances. The reader is referred to Nahinsky & Slaymaker (1969) for further details of the experiment.

RESULTS

In 69 of 180 S problems, S responded positively to two of the initial three BT stimuli. If S samples attribute values independently from the first positive instance and responds positively only when two sampled values appear on a stimulus, positive Rs to any two BT stimuli should be associated with a positive R to the third. Hence, the large proportion of positive classifications of two BT stimuli suggests hypothesis sampling rather than independent value sampling. However, if S samples a single value and responds positively upon appearance of the value, he would respond positively to two of the three BT stimuli. To explore the inference, all negative instances immediately following the first BT series and overlapping the first positive instance by just one value were tabulated, revealing four positive classifications for 50 such stimuli. Since BT stimuli overlapped the first positive instance by two values, the probability of classifying these stimuli positively should be twice that for the one-value overlap stimuli, if S samples only one value and responds on the basis of it. The total proportion of positive BT Rs was accordingly divided by 2 to arrive at a predicted proportion for the 50 one-value overlap stimuli, and the comparison showed significantly fewer positive classifications than predicted by single-value sampling.

If one hypothesizes that S samples values randomly and independently and classifies a stimulus positively when at least one of the sampled values appears, the prior analysis would not be appropriate. Let A and A^1 be the two values on the BT stimulus that overlap the first positive instance. In this case the probability of sampling either A or A^1 , $p(AUA^1)$, equals the probability of a positive R to the BT

stimulus. Assuming $p(A) = p(A^1)$, $p(AUA^1) = p(A) + p(A^1) - p(A)p(A^1) = 2p(A) - [p(A)]^2$, with $p(A)$ equal to the probability of a positive classification of a stimulus overlapping the positive instance by just one value. The observed probability of positive BT classification, $\hat{p}(AUA^1)$ equaled .55. Thus, solving for $\hat{p}(A)$ yielded a value of .329, in turn producing a predicted 16.45 positive Rs for the 50 one-value overlap post-BT stimuli. Again, the four positive Rs were significantly less than predicted, $z = 3.59$, $p < .0005$, and the hypothesis of responding on the basis of single values, multiply sampled, must also be rejected.

Another hypothesis tested in the experiment involved sampling with replacement after an error. The BT series following an error on the second feedback positive instance were analyzed. If resampling obeyed a modified sampling-with-replacement axiom, S would eliminate all hypotheses inconsistent with R assignments on the error trial and the preceding trial and sample from the remaining hypotheses (see Trabasso & Bower, 1966). In the experiment, one dimension could so be eliminated, and S should sample randomly from the nine hypotheses that could be formed using the two relevant dimensions. Thus, one in nine of the samplings should be of the correct hypothesis. However, each BT stimulus represents one two-value combination associated with the relevant dimensions, with one of the three stimuli representing the correct hypothesis. Hence, one of the three positive BT classifications, not one in nine as indicated in the original paper, should represent the correct hypothesis. Of the 100 positive BT Rs following a positive instance error, 72 involved the correct hypothesis. A comparison of this value with the predicted 33.33 results in a highly significant difference, as did the original comparison, $z = 8.09$, $p < .0001$. Hence, this test also results in a strong rejection of the modified sampling-with-replacement axiom as applied to multiple hypothesis sampling.

REFERENCES

- NAHINSKY, I. D., & SLAYMAKER, F. L. Sampling without replacement and information processing following correct responses in concept identification. *Journal of Experimental Psychology*, 1969, 80, 475-482.
TRABASSO, T., & BOWER, G. Presolution dimensional shifts in concept identification: A test of the sampling with replacement axiom in all-or-none models. *Journal of Mathematical Psychology*, 1966, 3, 163-173.